LMS Seminar series 2024 – 25

Multiphysics couplings in soft biological tissues: Focus on hydro-chemo-mechanical couplings around the cranio-maxillofacial region

Speaker: Adrien Baldit, Université de Lorraine
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Abstract

Based on expertise in mechanics applied to the biomedical field, this presentation will focus on examples in the cranio-maxillofacial region, with the aim of understanding multiphysical couplings in biological tissues. These case studies highlight the hydro-chemo-mechanical couplings via an approach that combines experimental, fundamental and applied developments. This order is not insignificant, with the intention of first observing the physical phenomena and then either choosing the fundamental tools or developing new ones that will enable properties to be identified and, finally, using these developments for transfer to the biomedical world. This will be an opportunity to give a non-exhaustive presentation of the techniques used in bio-mechanics, particularly in the "biomechanics and bioengineering of the musculoskeletal system" (BIO2MS) group at LEM3, to characterise and model biological tissues. In addition to identifying properties, these results will be used to guide the development of products for regenerative medicine and to better identify the effects of pathologies and therapies. To illustrate the need to develop research in this area, the temporomandibular joint disc will be used as an example (Tappert et al., 2022, 2024). To understand the inner functioning of biological tissues, it is essential to observe the various phenomena that occur physiologically. Couplings in soft tissues can be grouped under the term hydro-chemo-mechanical couplings. They thus take into account the biphasic character (fluid and solid) of the material in which bio- chemical reactions occur, from the microscopic to the macroscopic scale, in interaction with the mechanical behaviour (Egli and Ricken, 2019; Royer et al., 2019). The ANR HyCareMat project, of which the aim is to build and validate a hydro-chemo-mechanical predictive tool, will then be presented in order to gain an insight of mucoid matrices. At the same time, it will extend current knowledge of Wharton's jelly, a promising human tissue waste, used as a model material (Baldit et al., 2022). Ultimately, this project will improve the multiphysics response of Wharton's jelly for medical applications (Scomazzon et al., 2024).

About the speaker

Adrien Baldit is an associate professor in mechanics and biomechanics. He obtained a PhD in 2013 on "Analysis of hydro-chemo-mechanical interactions in biological tissues : application to the cell nutrition of intervertebral disc" at the University of Montpellier (France). After a postdoctoral fellowship in the INSIGNEO group at University of Sheffield (United Kingdom) in between 2013 and 2014, he obtained a tenured track position at the University of Lorraine (France) and more specifically at the École Nationale d'Ingénieurs de Metz since 2014. Currently, he is working on solid mechanics and biomechanics with a focus on hydro-chemo-mechanical interactions within biological tissue for regenerative medicine applications as well as open science and pedagogical innovations.

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